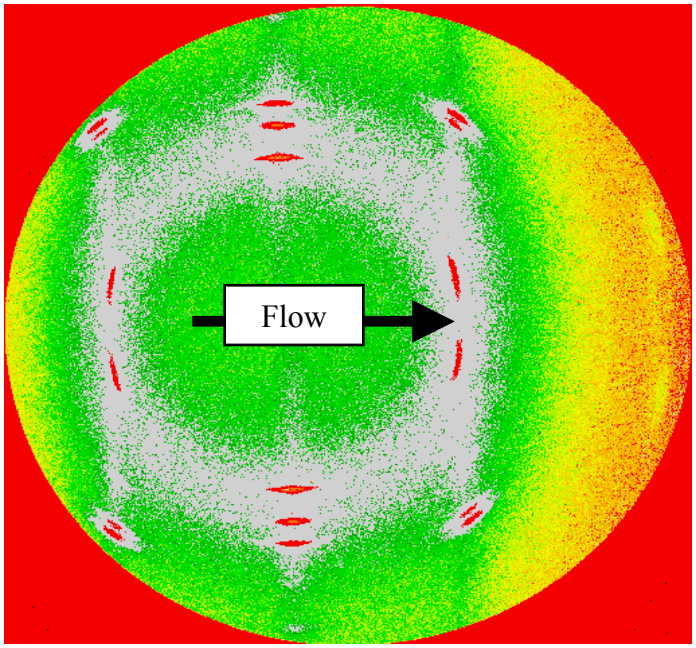
Making Them Faster and Better: Flow-Enhanced Crystallization of Polymers

Julie Kornfield, Caltech, DMR-9901403

The polymer industry produces the dominant class of materials in our lives at rates that are dizzying—over 70 billion kilos annually. More than 2/3 of the industrial production comprises polymers that crystallize, forming a nanocomposite of crystalline and noncrystalline material. Powerful new instruments developed at Caltech reveal molecular processes that accelerate crystallization up to a million fold during processing flows, enabling high production rates that make plastics, fibers, films and elastomers affordable. At the same time, flow can favorably alter the alignment of crystallites improving the strength of the material.

Macromol. **35**, 785, 1762 & 2583 (2002).



Wide angle x-ray diffraction during shear reveals induction of highly oriented crystals on timescales orders of magnitude faster than quiescent crystallization (here isotactic polypropylene in ~1/1000 of its quiescent crystallization time). Synchrotron measurements performed at Brookhaven National Lab., NSLS.

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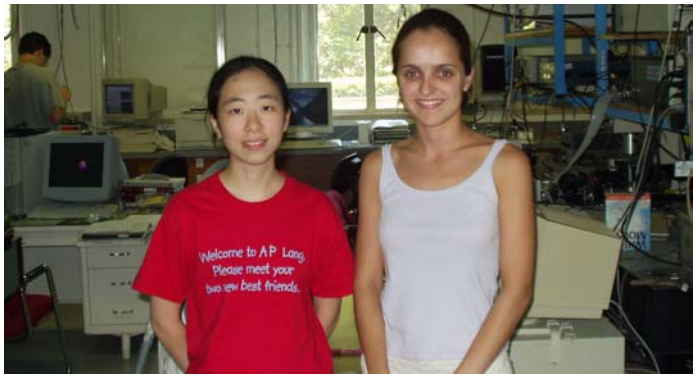
Education:

The research has been carried out by two undergraduates (Abel Bourbois and Philip Bell), three graduate students (Guru Kumaraswamy, Derek Thurman and Lucia Fernandez-Ballaster), and one postdoc (Jim Oberhauser). Jim is now an assistant professor at the University of Virginia and Guru is a scientist at the National Chemical Laboratories of India.



Stephanie Hsu and Lucia Fernandez-Ballaster.

Outreach:

Precollege students have been involved in this research through high-school summer internship (Stephanie Hsu), annual laboratory tours and demonstrations on "Take your Child to Work Day" and the Sally Ride Science Festival for middle-school girls.

Technology Transfer:

Industrial scientists are translating the results of our research into the design of new polypropylene resins. State-of-the-art computational design tools are under development that incorporate findings from this research.